XV. *A contribution to the life history of* Orina (Chrysochloa) tristis, Fabr., *var.* Smaragdina, Weise. By Thomas Algernon Chapman, M.D., F.Z.S.

[Read April 1st, 1903.]

Plates X and XI.

In our observations on some species of *Orina* presented to the Society by Mr. Champion and myself in December 1900, besides several viviparous species, we noted *Orina tristis* to have a habit that was not viviparous, nor yet strictly oviparous in the ordinary manner. Unfortunately our material of this species consisted of only one female beetle and our observations were accordingly somewhat restricted, so that I was pleased to meet with the beetle in some abundance on May 30th, 1902, near Pino, on Lago Maggiore. The beetles were disporting themselves, often a good number together, in the sunshine on a rather tall upright species of *Centaurea* that looked otherwise very like our *nigra*. I brought a number of beetles home and had them alive throughout the summer. They laid eggs freely, but began to die off about the middle of September. In the first week in October egg-laying seemed to be stopped, but a small batch of seven was laid October 18th, at which date only that number of beetles remained alive. Two males were still living on February 7th, 1903. I noticed in several beetles that died that the posterior tibiæ and tarsi were damaged or wanting and must have been eaten by the other beetles; whether this was a cause of death or only occurred after mortal illness had supervened I do not know. I twice found a beetle so damaged, that was still very decidedly alive.

I may note parenthetically that at the end of June we (Mr. Champion and myself) met with *Orina rugulosa* at San Sebastian. We found both beetles and larvæ, and observed the egg-laying to follow almost precisely the same methods as in *O. smaragdina*, indeed the eggs were almost indistinguishable from each other (I had some of the latter with me). They were on a very *nigra*-like species of *Centaurea;* the impossibility of obtaining

Centaurea at the places we visited in Spain brought to a very early conclusion my attempts to rear the two species side by side.

The account given in 1900 of the egg of *O. tristis* and of the hatching of the larva is correct as far as it goes, but wants much supplementing. When the larva is ready to emerge it shows very visibly through the egg-shell three black patches on either side, just above the spiracular line, on the 2nd and 3rd thoracic and 1st abdominal segments; except the spiracles, eyes, some mouth parts, and finally the cutaneous hairs it is otherwise colourless. These three patches are apparently ordinary portions of the cuticular covering that become hardened and matured at this early period for a special function, just as the 1st spiracular region and some other parts are solidly chitinised with special objects in various Lepidopterous pupæ, whilst the rest of the pupal integument is still soft. These three hard black patches are slightly convex and project centrally, but I cannot make out that they have any sharp or angular point.

Their function is to determine the lines of rupture of the egg-shell. The force used to open the egg-shell is one that is in common use with many insects, especially for emergence from the pupa. Here it is used for emergence from the egg. It is the secretion of air into the interior of the larva; the large air bubbles look as if in the general body cavity of the insect, and I am not positive that they are not, but as some air often escapes by the mouth and anus, when the insect is flattened, I incline to believe it is in the alimentary canal. The effect of this air being so secreted is to enlarge the bulk of the larva and exert a bursting tension in the egg-shell. If this tension became sufficient the shell would burst by explosion in some irregular manner, but the presence of these three hard points on either side of the larva is to increase the tension along a line passing along them, and so, long before the strain is sufficient to produce an explosive rupture, the egg-shell splits along each side over these points. The *modus operandi* is in principle precisely the same as that by which the pupæ of the Lepidopterous genera *Limacodes* and *Eriogaster* open their cocoons; in these a pressure, produced by air secretion within the insect, is localised as to the severest point of strain by a pupal beak, and so a lid splits off at the so-determined line.

When the egg-shell is split, a portion of the larva slightly protrudes through each slit, but the larva soon manages to turn round and escape through one of them head first. Since the larva can emerge through only one of them, why should there be two slits? These do not reach the top of the shell and are still further from reaching the bottom, but now and then they deviate from this symmetrical arrangement, one may be longer than the other, and this deviation may account for one slit only existing and that one reaching to the top of the egg-shell. This is comparatively rare, but still not infrequent, and was the only form I noticed in the few eggs I had in 1900. The two slits are probably useful in affording the larva escape by one, when the other is obstructed by the egg being against one of its neighbours, or possibly even glued to it or some other object, by some accident, either in the disposal of the parental glue that fastens the egg to the surface on which it is laid, or by a neighbouring egg being injured and its contents acting as a cement, as must not infrequently happen to eggs laid naturally on a leaf. The eggs are laid in regular order, in several adjacent rows, and are slightly inclined to the surface of attachment, instead of being perpendicular to it, so that one side of the egg is tolerably free, the other almost or even actually touches its neighbours. The larva could hardly hope to escape, if a solitary slit occurred on this side. I had made many observations of these beetles, of their egg-laying, of their hatching, had fed many of them from hatching to full-fed larvæ, and was still of the opinion that this species could not be *O. tristis*, because I had observed *O. tristis* lay eggs quite ready to hatch, whilst my insects from Pino laid eggs quite undeveloped. I was, however, puzzled to find that some eggs hatched in a few days whilst others did not do so for over a week. Some showed the imaginal jaws through the shell very early and so on. Still all the eggs I examined when new laid showed no coloured indications of the young larva.

On August 29th, however, a new experience awaited me. I found several eggs that had been laid since the 26th were already hatched. I determined therefore to more closely scrutinise the periods from laying to hatching of future eggs. Further light was closer at hand than I had expected. At 11 a.m., August 29th, the beetles were fed and as usual placed in a clean jar with fresh food, clean paper,

etc. At 2 p.m. I found three small batches of eggs laid, two presenting the usual clear aspect, but the third, which the beetle was at the moment depositing, consisted of two eggs that were actually hatching and of six others which presented the imaginal eyes well developed, but no jaws, spiracles, or other larval parts visible.

The eggs that I had supposed to be quite undeveloped, usually presented a rather opaque aspect, except at the unattached (head) end, where about one-fourth or one-fifth of the egg was apparently occupied with clear yellow fluid, and it had struck me as curious that the eye-spots, which were the first imaginal parts to be seen, occurred on this transparent area. I now, however, understood that this transparent region had no relationship to a similar one that occurs in the newly-laid eggs of Zygaenids (*Anthrocera*) amongst the Lepidoptera, and that it was really the larval head, after considerable development of the embryo had taken place. Most of the eggs are laid at this stage, when the embryo is well-developed but before the eye-spots appear. I now carefully examined other eggs and found some with a fairly uniform aspect, from end to end. I saw several such eggs actually laid, and examined them immediately, and found I could treat them as transparent objects sufficiently well to see that the greater part of their contents were in small rounded masses, but that at the free end there was within the shell a delicate membrane and inside this several large rounded processes, one nearly half the diameter of the egg across, another smaller, with a clear angular space between them, and smaller ones extending down the egg. I make no doubt these are the early cephalic lobes of the embryo with further segmental divisions.

So far as I have noticed, these are the youngest eggs that are laid, the greater number are rather more advanced, and they may even be so far advanced as to show the eye-spots, and as an exceptional occurrence, they may be just ready to hatch.

I regret that I am ignorant of the methods of examining the younger eggs, and of overcoming the difficulties presented by the tough leathery egg-shell and the very delicate contents, but I feel satisfied that what I have been able to observe justifies the conclusion just stated, that the eggs *have* always undergone some development when laid and sometimes have made a near approach to hatching.

Those of *O. tristis* I watched during August two years ago were well advanced when laid, none were so this year till towards the end of August, so that it may be, that only towards the end of its egg-laying are the ova retained until the larva is well-developed. But it is also certainly the case that the ovum is not fertilised at the moment of deposition, but at some interval previous to that time, notwithstanding that the egg-shell is a solid structure similar to that of eggs that have (as, in fact, these always have) to exist externally for some time before hatching.

They have, in fact, taken the first step towards becoming viviparous, and it is of interest to note that the step is not a definite and constant one, but varies from a habit nearly that of ordinary egg-laying insects, to one that is almost that of viviparity, not in different races of the beetle, or even in different individuals, but apparently in the same individual possibly according to its age. Not certainly according to differences of treatment, as all my beetles were kept together, yet their habits were not always all alike.

It is interesting to notice that Mr. W. M. Wheeler in the Journal of Morphology (Boston), vol. iii., 1889, figures the young larva of *Doryphora decemlineata* as existing within the egg-shell as almost identical in appearance with that of *O. tristis*. The only difference I note in his figure or description is that the hatching spines in *D. decemlineata* have definitely sharp apices, those of *O. tristis* being comparatively flat and blunt. He describes the hatching as taking place by the contained larva moving within the egg-shell so as to cut it with these spines, and says that it cuts the egg on both sides and that these two incisions meet over the apex, making one large opening. I should certainly like to see this process take place: still I see no reason to doubt that it is very possible for similar structures in allied species to exercise the same functions, or at least to attain the same objects in very different ways. A remarkable instance of this I mentioned lately to the Entomological Society in the case of two species of Lepidoptera, *Hybocompa milhauseri* and *H. dryinopa*, in which a similar pupal spine is used in quite a different way in each species for opening the cocoon.

In *O. tristis* it is certainly the case that no movement of the young larva takes place before the opening in the egg is formed, and that it takes place by rupture under tension

from within, and merely the place where it shall occur, but not the actual rupture, being determined by the hatching spines.

It is certainly matter of some interest from a classificatory point of view, to find the egg and the embryo within it and the method of hatching (hatching spines, etc.), so very nearly identical in *Doryphora decemlineata* and in *Orina tristis*. Wheeler's observations especially relate to the development of the embryo; and as his observations were made entirely on eggs already laid, and he begins with the egg segmentation preceding the embryo, it is clear that in *Doryphora* there is no quasi-viviparity as in *O. tristis*. There is, in his paper, no suggestion of the possibility of such a thing. He would certainly have noticed and recorded it had there been any trace of it, although it was not strictly the subject of his paper.

I believe *Doryphora* and *Orina* are not classified very closely together. It may be that this method of hatching is common to many species of Chrysomelids; if so, record of it ought certainly to be more frequent than it is.[1]

Immediately after each of its three subsequent moults, the skin of the larva is quite colourless, exhibiting all its interior anatomy, tracheæ, alimentary canal, etc., but it is sufficiently loaded with yellow fat and fluids to make details difficult to observe. It rapidly (in half-an-hour or so) becomes black. At these moults there is no trace of these hatching spines to be noticed. Two circumstances attracted my notice; one was that the larva used inflation to assist the rupture of the effete larva skin. This is not pushed away towards the tail and so stretched in front till it splits as is the method in Lepidoptera, but the whole larva skin is fully on the stretch, and finally slits down the dorsum, the new white larva protruding at once and then creeping out slowly, leaving the empty larval skin slightly contracted, but still looking uncommonly like a living larva, and nowhere with its segments crushed together. It merely takes up the aspect of a younger larva with its subsegmental ridges, when the tension of a full-fed larva within it is withdrawn.

The larva when newly moulted and still colourless is seen to be especially translucent in the thoracic region, and several larger and smaller globules of air are seen to

[1] Mr. Jacobi informs me that the Colorado beetle is not a *Doryphora*, but belongs to a genus very near to *Orina*.

occupy this region; that they are in the alimentary canal seems almost certain, as they escape by the mouth when the larva is subjected to pressure.

The other circumstance connected with moulting that seemed to me curious, is no doubt so, only because my experience in watching the moulting of larvæ has been almost entirely amongst the *Lepidoptera;* in these, the larva always completely voids the alimentary canal at a moult. A newly-moulted larva has no food contents at any stage. In *O. tristis* the anterior part of the alimentary canal contains no food, but the hinder portion, in several loops, in the abdominal segments, is more or less loaded. The effete larval skin appears to be held in place so that the larva may crawl out of it by a more or less half-dried fæcal deposit glueing the anal extremity to the leaf.

The rupture in the larval skin divides the head into two lateral (epicranial ?) pieces, and the clypeus with the mouth parts and slits down the thoracic and two first abdominal segments dorsally as if along a dorsal suture; the third abdominal segment is often slit in the same way, and I have once seen the fourth slit also, but irregularly towards one side, as if any dorsal suture was here certainly absent, as it probably is in the third abdominal segment.

At the moult to pupa the skin collapses, and so far as can be judged by the condition of the cast skin the process of moulting is very similar to that in Lepidopterous larvæ.

The eggs are not absolutely uniform in size and shape. Their length is about two-and-a-quarter times their width; their sides are not quite straight but curved, so that the middle of the egg is the widest part; sometimes the longitudinal section is an ellipse, at others there is some tapering towards one or both ends (as in the small end of an egg).

The actual dimensions of four eggs measured was :—

Long	2·15	2·25	2·25	2·32 mm.
Wide	1·0	0·94	1·01	0·97 mm.

It is to be noted, that as the embryo is always developed with the head to the free end of the egg, and has already advanced in its development so far as to already have its head to that end when laid, the orientation of the embryo in the egg must be determined by its relations to the ovarian tubuli in which it develops, and as these are coiled in all directions, gravity has no share in the determination,

but simply which is the end of the egg nearest the top of the tube.

Though a dissected beetle shows the tubules loaded with eggs of all sizes, my observations go no further in this direction; it would be of interest to know whether the eggs attain their full size before they are fertilised and development begins, or whether they grow after development of the embryo is begun. Probably not, but as the embryos of the viviparous species grow considerably whilst still in the tubules, only definite observation can determine what happens in this species.

When hatched the larva of *O. tristis* is colourless, except for the eyes, jaws, spiracles and the six black spots that may be seen through the egg-shell, but it very soon becomes quite black, with the exception of the fine brown hairs which are plentifully scattered all over it. The head and prothorax are at this stage exceptionally large, forming fully two-fifths of the length of the larva. The legs are nearly colourless and the under-surface is pale, the larva is blacker than at later stages, the blackness but encroaching a long way on to the ventral surface.

The intersegmental depression divides the segment deeply, but terminates some way above the spiracle, the anterior and posterior subsegments meeting as a raised ridge, below which the spiracle lies in a depressed triangular area that extends to the front of the segment. Length 2·0 mm., greatest breadth 1·0 m.

At the first moult, *i. e.* in the second instar, the head and prothorax remain dirty yellow for some time after the abdomen has become black, and they remain a little paler throughout the instar. The subsegments still meet in a definite ridge above the spiracle, which is now hardly in a depressed area, but has the diagonal grove separating 1st and 2nd flange below it; the anterior branch of the subsegmental incision exists, but is not at all pronounced or visible in all attitudes of the larva. Length 3·0—4·0 mm., width up to 2·0 mm., when contracted is almost a sphere of 2·5 mm. in diameter.

In the third instar the larva is very similar to the second, the head and prothorax are still a little paler than the abdomen. The branch of the subsegmental incision is very short, but distinct in the 2nd instar, and is very similar in the third. Length 5·0—8·0 mm., width 2·5—3·0 mm.

The full-grown larva has the general aspect and structure of *Orinas*, as described (Ent. Soc. Trans., 1901, p. 18). The thorax is relatively smaller than in some other species, and looks even less than it is, by comparison, being of the same dark colour as the rest of the dorsum, without any kind of paler tinting. The colour of the dorsum is black with a bronzy shade, due either to texture and polish, or also perhaps to a certain amount of the olive or brownish tint that appears laterally and predominates ventrally, declaring itself in the finer depressions of the minute wrinklings. These wrinklings are apparently the same as in the other species described. They are generally in transverse lines, each elevated line being somewhat broken by partial or complete sulci in more or less diagonal directions which are sometimes independent, but are sometimes the transverse sulci anastomosing. So far as it is possible to count them, there are about thirteen or fourteen transverse ridges on each segment. The transverse depressions, which are most marked about the fourth or fifth abdominal segment, and indicate subsegmentation of the segments, and varied somewhat in each species previously described, are well marked, and are probably characteristic. They smooth out nearly completely in some attitudes. Dorsally it is about central, the anterior margin highest. Rather lower than half-way down to the spiracle, it sends back a branch from its anterior margin, that fades out before reaching the dorsum. The spiracle is a minute raised ring surrounded by a small smooth surface; just below this is a very definite diagonal groove, passing backwards and ventrally. In certain attitudes the dorsal subsegmental groove passes down as little more than a fine line in front of the spiracle, and seems continuous with this diagonal groove. This diagonal groove is in fact the demarcation between the spiracular and subspiracular flange. The segmental incision in the subspiracular flange is double, a sulcus from below passing up behind one descending from the dorsum. The marginal (3rd) flange is simple, its upper and lower grooves being longitudinal.

The colour of the lower surface is yellowish-brown, overlaid by a clouding of small blackish spots. The head and prothorax has a tolerable coating of fine brown hairs; these have to be looked for, the surface having at first glance a glabrous aspect. After they are seen, one decides that the

abdomen really is glabrous, till a closer search shows that it carries a large number of fine brown hairs, less than half the length of those on head and prothorax.

The legs and incisions are of the same olive-brown already noted.

Length 10–14 mm. Width head 2·3 mm.
„ prothorax 4·0 mm.
„ mesothorax 3·8 mm.
„ 5th abl. 5·0–6·0 mm.

The colour of the larva varies a good deal. Taking it as typically black above and pale luteous olive below, the whole of the mouth region of the head belongs to the pale lower region; the demarcation between the two regions being the lower margin of the subspiracular flange (middle ridge of the triple marginal flange). In many specimens, however, the anterior portion of the larva, especially the prothorax, is dorsally paler, without being pale enough to suggest the yellow colouring this segment has in some other species. The marginal area may also be a little more invaded by the ventral paleness.

The blackness of the dorsum is also variable. In a majority perhaps it is a brownish-olive, approaching black, with a bronzy aspect in some lights, its paler tones being due to lighter colouring (or comparative thinness of pigment) in the bottoms of the minute sulci of the finely-wrinkled surface. In some specimens the blackness is dense and undoubted over the whole dorsum.

The most remarkable fact as to the colouring observed was as to two specimens, differing apparently in no way from any of the others, that formed part of a number turned out in the field: these two were placed on open flowers of the *Centaurea* when going out, and were still there half-an-hour later when returning, but in the sun were now of nearly as bright a metallic green as that of the imago. I have been unable to induce others to exhibit this colouring.

According to its attitude the segmentation of the larva looks rather different. The prothorax is of course always very evident, and when the full-fed larva is active and lively the mesothorax is a good long segment, much like the others, but with the two ridges lower, especially the anterior one. When at rest, however, and especially if the larva be a little sulky and only half-grown,

the mesothorax partially or wholly disappears beneath the prothorax, which may even slightly overlap the metathorax. The 2nd thoracic segment is in these circumstances easily overlooked, and owing to the backward direction of the coxæ it is even difficult to believe that the 2nd and 3rd pair of legs do not actually belong to the 3rd thoracic and 1st abdominal segments, taking each of these in fact for the segment in front of it.

The 7th abdominal segment is the last coloured like the others, and has the appearance of a broad anal plate, the 8th is somewhat coloured, but is simple in structure and retractile, the 9th and 10th are colourless and retractile, the 9th forming a foot used in all progression.

The hairs, which seem to disappear as the larva passes to its later instars, do not in fact do so. On the contrary they persist, though the larva grows however, they do not, but maintain almost precisely the same size and distribution they had in the 1st instar. Their length in the 1st instar is tolerably uniform all over the larva, viz. ·25 to ·30 mm. in length. In the 2nd and 3rd instars they are almost precisely the same, but of course make relatively a much less show on these larger larvæ. In the last instar they remain of almost identically the same length on the head, over the dorsum and posteriorly, but laterally they have actually dwindled to a length of only from 0·06 to 0·20 mm.

The hairs on the appendages and many of those on the head appear like the ordinary tactile hairs terminating in a solid sharp point, but the great majority, and nearly all those on the general surface, are expanded at the tips, and appear to be hollow, making the extremity trumpet-shaped, but not so widely expanded perhaps as this suggests.

The arrangement of the hairs may be described as irregular, merely, no doubt, because it is too complex to describe; on the 2nd thoracic and following segments they are placed on the summits of the two subsegmental ridges, on 2nd thoracic almost in one row on each, on 3rd the row on front ridge is a little irregular, on the back one they are better described as in two rows. On the front ridges of the 1st and 2nd abdominal they are in two rows, the hairs in the rows alternating, they are more numerous on the back ridges, whilst on both ridges of 5 and 6 they may be described as in three or four rows, but in all cases without

the strict regularity that the idea of rows implies; they are wanting near the incisions, both segmental and subsegmental. The 8th and 9th abdominal segments possess hairs, especially a row of strong ones along their hind margins, and 10 is not without finer hairs. Beneath the abdomen each segment possesses shorter hairs, about ten on each side, placed with some but not absolute bilateral symmetry. The subspiracular flange on each segment has a separate chitinous plate carrying four or five longer and four or five shorter hairs.

The hairs on the prothorax are very numerous, and except a certain regularity round the margin, are equally but irregularly distributed over the whole surface, they number about 110 on either side.

The pupa of *O. tristis* is 10 mm. long and 4·5 deep from back to front across the 3rd abdominal segment, and 6·5 wide from knee-joint to knee-joint of 2nd legs, but this when they are a little set forward, the natural position would give perhaps nearer 5·3 mm. This is from a small specimen, a larger one would probably be 12 mm. long. The colour is pale whitish tending to flesh-colour, and deepening as the beetle matures.

The head is well bent forward, *i. e.* ventral, so that the face is directed ventrally, and the abdomen is also curved forwards, so that the ventral line is nearly straight, running from the frons down the clypeus, labrum, labium, tarsi to the anal point. The dorsum, on the other hand, presents a curve from one of these points to the other, and distant from it (as above noted) 4·5 mm. at the widest point.

The antennæ pass first backwards then down behind the 1st femora, their apices pointing forwards between the 1st and 2nd knee-joints. The wings pass down between the 2nd and 3rd legs, and curving round to the front, hide the greater part of the 3rd femora and tibiæ, and do not meet in front by about 2·6 mm. The first wings (elytra) show several longitudinal ribs or veins of which one on either side is marginal, and three over the centre are more marked than the others. The 2nd wings (wings) are visible dorsally in a narrow slip passing under the 1st wings, and their apices also appear beyond the first over the 3rd tarsi.

The jaws, labrum, labium with palpi, the maxillary palpi of three (?) joints passing straight backwards are very

distinct, but these, with the legs and wings, are thickened and fleshy (compared with the imago), but present no spines or other definite armature except a few fine brownish hairs on the upper outer exposed aspects of the femora. The ventral aspect of the abdomen is equally smooth, but dorsally all the segments have a greater or less supply of short pale brown hairs. Over the front of the head and the prothorax these are especially regularly and thickly scattered. The prothorax is a large, somewhat square plate, 5·5 × 4·5 mm., as in the larva and imago. The mesothorax is narrow, 1·3 mm., with a projecting angle at centre of its posterior margin; just in front of this is a small raised boss, which carries a few, the only, hairs on the segment. The metathorax is again rather wide, 1·7 mm. (the projecting point of mesothorax makes these measures unduly favourable to that segment), with a dorsal longitudinal grove, it is very smooth and polished, and possesses only some half-dozen scattered hairs on each side, two on either side near the middle of the hind margin being especially strong.

The first abdominal segment is narrow (about 0·6 mm.), and has a central dorsal grove, which on the second is replaced by an elevation, the remainder having no dorsal peculiarity. The first six abdominal segments are narrow (about 5·0 mm. together), each however rather broader than the one in front. The next is longer (2·0 mm.) and is apically produced to an angle. Each of these (1–7 abdominal) has a spiracle, a small round chitinous ring, about 1·0 mm. across, below which the dorsum of the segment is rounded off, forming a lateral flange. 1–6 carry a fringe of hairs along their posterior margins, which are carried round the margin of the flange, and where more especially they are less a fringe, and more uniformly scattered over the surface. Abdominal 7 has hairs scattered all over it except its extreme anterior margin.

Dorsally 8 and 9 (abdominal) rapidly taper to a fine brown chitinous point with which 9 terminates, 9 has a very few inconspicuous hairs, on 8 they are more numerous and evident but less so than on 7.

Ventrally 8, 9, and 10 are marked by sundry elevations no doubt marking the genitation.

On March 4th, 1903, there still remained alive two males of the beetles taken at Pino on May 30th, 1902. It is not, however, the case that these represent the amount

of survival amongst the beetles taken. Comparing these with the numbers that died, and eliminating those that escaped, that were given away, or were otherwise disposed of, these two represent the survivors rather of from eight to ten beetles living in August 1902.

About this date (March 4th, 1903) I examined the pot in which a number of larvæ had gone down in September and October, and was vexed to find that the earth was apparently quite dry, and two larvæ that I unearthed from near the surface were apparently quite dead and dried up, with the ventral and dorsal surfaces almost in contact. Placing these in warm water, after twenty-four hours both were alive and active. Though still looking somewhat starved and contracted, they obviously had a good deal of tissue within their skins.

I was, therefore, encouraged to damp the pot of earth and put it in a warm place. Unfortunately again, I overdid this.

On March 23rd I found a perfect beetle had emerged, and forthwith examined the pot and contents. I found it contained several beetles ready to emerge, one living and one dead pupa, a number of dead larvæ, distended almost to bursting by excess of imbibition but really close on pupation, and others that had died at an earlier stage.

Disappointing as this result was, disappointing also because so much due to my own want of intelligent care, still, it enables me to say that I have reared the beetle from the egg, and also to describe and figure the pupa.

The hibernating chamber of the larva, in which it pupates in the spring, remaining probably as a pupa from two to four weeks, according to temperature, is nearly spherical, and about $\frac{5}{8}$ inch in diameter, with the interior wall pressed smooth.

The following data, giving dates of hatching of batches of eggs laid at the same time, give some indication of the various degrees of maturity of the eggs at the date of laying.

Laid September 22–23			Laid September 12–13		
3	hatched	,, 26	1	hatched	,, 15
17	,,	,, 28	3	,,	,, 17
22	,,	,, 29	14	,,	,, 18
18	,,	,, 30	72	,, by	,, 21
10	,,	October 1	57	,, ,,	,, 23
leaving 14 still to hatch.			5 mature eggs remaining.		

Laid September 17
9 hatched „ 24
60 „ „ 26
15 „ „ 27
2 „ „ 28
2 addled.

Laid September 13–15
1 hatched „ 17
1 „ „ 18
12 have died and blackened that were ready to hatch when laid.
5 hatched September 21
34 „ „ 23
17 „ „ 24
4 „ „ 26

Laid August 5–6
1 hatched „ 8
2 „ „ 10
1 „ „ 13
12 „ „ 14–15
10 left of which the last hatched 17
Larvæ 3 have moulted
1st on August 19
All „ 24
4 have moulted
2nd on August 26
All on „ 29
Many have moulted
3rd on September 4
Most „ 7
All „ 9
Nearly all full-grown 15

After no eggs laid for 10 days, 7 were laid on October 18th, 1 near hatching and 6 with top end transparent. These show eye-spots on 20th on which date one more egg laid with all spots visible.

The following actual notes show the time taken by the larvæ to feed up.

Batch laid August 12
4 hatched „ 17
Many „ 19
Several 1st moult „ 24
All „ „ „ 29
Several 2nd moult „ 31
Most „ September 4
Some 3rd moult „ 4
Nearly all full-grown „ 15

Hatched August 3–4
1st moult „ 12
3 specimens 2nd moult 17
3 specimens 3rd moult 24
Eating little and very fat „ 31
Had eaten nothing for some time and allowed to go down on September 9.

Hatched August 12
Most in 2nd skin „ 19
Six in 3rd skin „ 26
Some in 4th skin „ 29
Nearly all in 4th skin 31
All September 4
Full-fed „ 9

Laid August 7–8
1 hatched „ 12
2 „ „ 13
10 „ „ 15
7 in 2nd skin 21 rest removed
2 moulted to 3rd August 26
All in 3rd skin „ 29
5 in 4th skin September 2
All „ „ „ 4
Full-fed „ 13

Hatched September	18
Full-fed 2nd skin	„ 27
All in 3rd skin	October 4
2 in 4th skin	„ 6
All in last skin (4th)	„ 12
Full-fed	„ 15
Going down	„ 18

Hatched September	13
Most in 2nd skin	„ 21
„ 3rd „	„ 27
Many in 4th skin	„ 30

Eggs laid August	3–4
Those (11) hatched	9–12 removed
The rest hatched August	13–15
Several in 2nd skin	„ 17
All „ „	„ 19
Some in 3rd „	„ 26
Some in 4th „	„ 29
Nearly all in 4th skin Sept.	2
All „ „	„ 4
Full-fed	„ 13

It may be useful to summarise the items of the life history of *O. tristis* noticed above. The beetles emerge from the ground in May, and eating freely of the food-plant (*Centaurea* sp.) and pairing frequently, lay eggs abundantly during June, July and August, and even on to November, some specimens living (in confinement) until the following March.

The eggs are rarely laid singly, usually in small batches up to twelve or twenty, or even considerably more. When laid the eggs have already undergone some development, sometimes only to the mulberry stage, usually the larva is already largely developed, and more rarely the eggs may be ready to hatch. This seems to be more frequent later in the season. The eggs hatch by two slits forming, under internal pressure caused by the secretion of air in the alimentary canal of the young larva, their site being determined by the presence of "hatching spines." The larvæ moult three times, the effete skin being similarly split by pressure from "inflation."

They feed up in about a month, rather longer in cool weather, shorter probably in hot, and then bury themselves in the earth to a depth of one to five or six inches, remaining unchanged to the following March or April, when the further changes are rapidly gone through. It seems possible, but I have no evidence whatever to make it at all probable, that the earlier larvæ feed up and may emerge the same year.

Postscript, June 11th, 1903.—As an indication of the date of the appearance of the beetle, on April 27th, 1903, at the habitat of the beetle at Pino, only two specimens of the beetle could be found, these happened to be a male and female; the Centaurea was only some twelve inches high. On May 30th, 1902, it was three to four feet high,

but not in flower, and the beetles were plentiful. On May 30th, 1903, two beetles were found at Reigate in my garden, from larvæ turned out last autumn, and one or two a day have appeared since. These are all soft and immature.

The *Orina* taken at Pino April 27th, paired on May 7th and May 8th, but not for long periods. They were placed again in the same jar May 24th, and remained paired for forty-eight hours on May 25th, 26th and 27th. The female again paired with one of the Reigate beetles May 30th and 31st. On June 4th she laid two eggs *ready to hatch*, and two more on the 5th. Of these one failed to hatch, the others hatched on 5th and 6th, and larvæ are now feeding.

These are probably the result of the pairing of May 7th and 8th, but this is by no means certain. The beetles do not seem happy or to feed freely, when kept solitarily.

Explanation of Plates X and XI.

Plate X.

Fig. 1. Egg ready to hatch, showing "hatching spines" and other parts of contained larva × 13.
2. Egg-shell showing slits made at hatching × 13.
3. Larva in 1st stage × 30.
4. „ 2nd „ × 14.
5. „ 3rd „ × 10.
6. „ 4th „ × 6.
7. „ „ „ × dorsal view 6.
8. Pupa lateral view × 6.
9. „ ventral „ × 6.

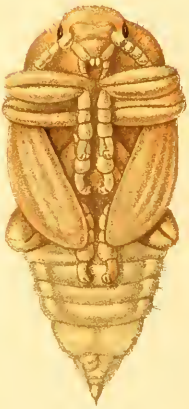
Plate XI.

Fig. 1. Newly-hatched larva squeezed flat, showing hatching spines and air bubble in gullet, etc.
2. Another specimen, air bubble pressed out, now entangled with legs.

3.

7.

4.



9.

5.

6.

2.

1.

3.

E C. Knight del.

Mintern Bros. Chromo

Orina tristis var. smaragdina

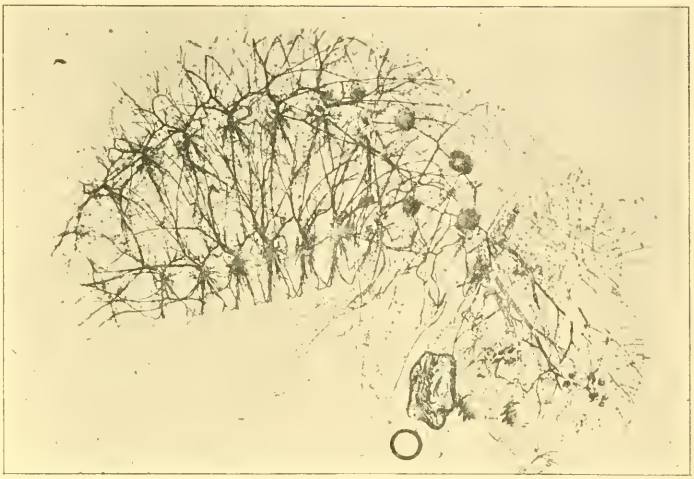


Fig. 1.

Fig. 2.

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Orina tristis, var. smaragdina.